ESA Section 7 Consultation No: F/NWR/2002/00930

National Marine Fisheries Service
Endangered Species Act Section 7 Consultation
and Magnuson-Stevens Act
Essential Fish Habitat Consultation

Agencies: The National Marine Fisheries Service (NOAA Fisheries)
The Environmental Protection Agency (EPA)

Species/ESUs: Ozette Lake Sockeye Salmon *(Oncorhynchus nerka)*

Activities Considered:

1. Issuance of Permit No. 1386 to the State of Washington Department of Ecology (DOE).

Consultation Conducted By: Protected Resources Division (PRD) of the Northwest Region, NOAA Fisheries (Consultation Number F/NWR/2002/00930)

Approved By: for ______________ for D. Robert Lohn, Regional Administrator

Date: 9/19/02 (**Expires on:** December 31, 2006)

This document is the NOAA Fisheries' biological opinion for its review of proposed Endangered Species Act (ESA) section 10(a)(1)(A) permit action described below, prepared in accordance with section 7 of the ESA of 1973, as amended (16 U.S.C. 1531 et seq.). This biological opinion is based on information provided in the application for the proposed permit, comments from reviewers including NOAA Fisheries' Northwest Fisheries Science Center, published and unpublished scientific information on the biology and ecology of threatened salmonids in the action area, and other sources of information. A complete administrative record of these consultations is on file with the NOAA Fisheries' Northwest Region (NWR) in Portland, Oregon.

CONSULTATION HISTORY

NOAA Fisheries proposes to issue one permit authorizing scientific research studies of threatened Ozette Lake sockeye salmon. The consultation history for the permit is summarized below.

Proposed New Permit

Permit 1386 - DOE

On May 8, 2002, NOAA Fisheries' PRD received a request from the DOE for a research permit to allow take of Ozette Lake sockeye salmon. The request included a letter and permit application from Keith Seiders (the applicant). On May 10, NOAA Fisheries' PRD requested additional information to complete the application. NOAA Fisheries' PRD received the information from the DOE on May 16, 2002.

DESCRIPTION OF THE PROPOSED PERMIT

The new permit action considered in this Opinion would be in effect until December 31, 2006.

Common Elements

Research permits list general and special conditions to be followed before, during, and after the research activities are conducted. These conditions are intended to: (a) manage the interaction between scientists and ESA-listed salmonids by requiring coordination of research activities among permit holders and between permit holders and NOAA Fisheries; (b) require measures to minimize permitted research impacts on target species; (c) and report information to NOAA Fisheries on the nature and impact of the activities on the species of concern. The following conditions are common to all of the NOAA Fisheries' permits authorized. In all cases, the permit holder must:

1. Anesthetize each ESA-listed fish that is handled out-of-water. Anesthetized fish must be allowed to recover (e.g., in a recovery tank) before being released. Fish that are simply counted must remain in water and do not need to be anesthetized.

2. Handle each ESA-listed fish with extreme care and keep them in water to the maximum

extent possible during sampling and processing procedures. The holding units must contain adequate amounts of well-circulated water. When using gear that captures a mix of species, ESA-listed fish must be processed first to minimize the duration of handling stress. The transfer of ESA-listed fish must be conducted using a sanctuary net that holds water during transfer, whenever necessary to prevent the added stress of an out-of-water transfer.

3. Stop handling ESA-listed juvenile fish if the water temperature exceeds 70 degrees Fahrenheit at the capture site. Under these conditions, ESA-listed fish may only be identified and counted.

4. Use a sterilized needle for each individual injection when using a passive integrated transponder tag (PIT-tag) to mark ESA-listed fish. This is to minimize the transfer of pathogens between fish.

5. Notify NOAA Fisheries in advance of any changes in sampling locations or research protocols and obtain approval before implementing those changes.

6. Not intentionally kill (or cause to be killed) any ESA-listed species the permit authorizes to be taken, unless the permit allows lethal take.

7. Exercise due caution during spawning ground surveys to avoid disturbing, disrupting, or harassing ESA-listed adult salmonids when they are spawning. Whenever possible, walking in the stream must be avoided, especially in areas where ESA-listed salmonids are likely to spawn.

8. Use visual observation protocols instead of intrusive sampling methods whenever possible. This is especially appropriate when merely ascertaining whether anadromous fish are present. Snorkeling and streamside surveys will replace electrofishing procedures whenever possible.

9. Comply with NOAA Fisheries' backpack electrofishing guidelines when using backpack electroshocking equipment to collect ESA-listed fish.

10. Report to NOAA Fisheries whenever the authorized level of take is exceeded, or if circumstances indicate that such an event is imminent. Notification should be made as soon as possible, but no later than two days after the authorized level of take is exceeded. Researchers must then submit a detailed written report. Pending review of these circumstances, NOAA Fisheries may suspend research activities and/or reinitiate consultation to allow research activities to continue.

11. Submit to NOAA Fisheries a post-season report summarizing the results of the research

and the success of the research relative to its goals. The report must include a detailed description of activities, the total number of fish taken at each location, an estimate of the number of ESA-listed fish taken at each location, the manner of take, and the dates/locations of take.

Additional conditions specific to this permit are described below and in the permit.

Some of the activities identified in the proposed permit action will be funded by the EPA. The agency is also responsible for complying with section 7 of the ESA because it is funding activities that may affect listed species. This consultation examines the activities it proposes to fund and thus will fulfill its section 7 consultation requirement.

Finally, NOAA Fisheries will monitor actual annual takes of ESA-listed fish species associated with scientific research activities, as provided to NOAA Fisheries in annual reports or by other means, and shall adjust annual permitted take levels if they are deemed to be excessive or if cumulative take levels are determined to operate to the disadvantage of the ESA-listed species.

The Permit

The following information discusses the permit, overall amounts of take being requested in the permit application, the general actions with which that take would be associated, and general location of research activities. "Take" is defined in section 3 of the ESA; it means to harass, harm, pursue, hunt, shoot, wound, kill, trap,capture or collect or to attempt to engage in any such conduct. Detailed, action-by-action breakdowns (i.e., how much take is associated with each activity in the permit) are found in the Determination of Effects section.

Proposed New Permit

Permit 1386 - DOE

NOAA Fisheries proposes to issue a permit to the DOE for annual takes of adult and juvenile Ozette Lake sockeye salmon during the course of research designed to evaluate level of toxic contaminants in surface waters, sediment, and aquatic animal tissues in Ozette Lake and several other basins throughout Washington State. This Biological Opinion only analyzes the proposed permit actions in the Ozette Lake basin. The study will benefit listed and non-listed species by identifying areas of high toxicity and using that information to clean up affected waters in accordance with the Clean Water Act. The DOE proposes to capture (using gill, fyke, and tangle nets and electrofishing), handle, and release two adult and ten juvenile Ozette Lake sockeye salmon. The DOE estimates juvenile sockeye mortality to be up to 1% of the number encountered.

The Action Area

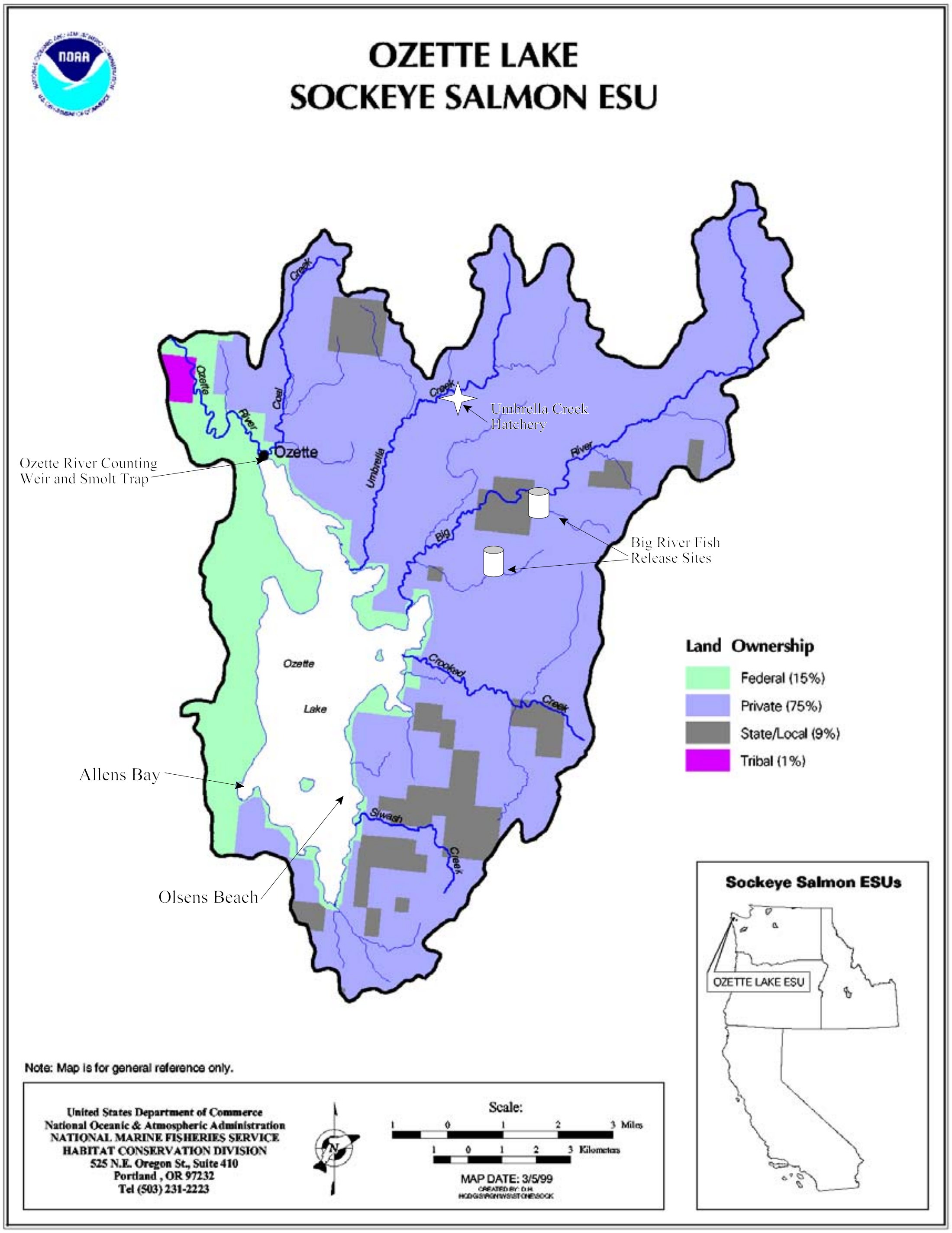
The action area (Figure 1) for this consultation on threatened Ozette Lake sockeye salmon includes all lake areas and river reaches accessible to listed sockeye salmon in Ozette Lake, located in Clallam County, Washington, and the Ozette River. The range of the ESU also includes nearshore estuarine and marine areas used by sockeye salmon on the Washington coast for juvenile emigration, early rearing, and returning adult migration. Critical habitat was designated for Ozette Lake sockeye salmon on February 16, 2000 when NOAA Fisheries published a final rule in the Federal Register (65 FR 7764). However, the critical habitat designation for Ozette Lake sockeye salmon was vacated and remanded to NOAA Fisheries for new rulemaking pursuant to a court order in April 2002. In the absence of a new rule designating critical habitat for Ozette Lake sockeye, this consultation will include an evaluation of the effects of the proposed actions on the species' habitat to determine whether those actions are likely to jeopardize the continued existence of the species.

Ozette Lake is a large (2,954 hectare) lake with a mean depth of 40 m and a maximum depth of 96 m (Bortleson and Dion 1979). The lake is near the northwest tip of the Olympic Peninsula in Olympic National Park, Washington. The lake thermally stratifies during May through October, and near-surface temperatures average 21˚C during summer. Water level fluctuates 2.7 m during the year. The lake is fed by numerous small tributaries and is drained by the Ozette River, which flows 7.8 km to the Pacific Ocean (Dlugokenski et al. 1981). The Makah Tribe's Ozette Reservation bounds the Ozette River for a small distance near the mouth. Tributaries in the Ozette Lake Basin, including Umbrella Creek, Big River, Coal Creek, and Crooked Creek, have low gradients and are small, relying predominately on rainfall as a water source. The Olympic Peninsula receives 160 to 380 cm of precipitation per year, and the lowest annual sunshine (averaging less than 1,800 hours/year) of anywhere in the continental United States (Gustafson et al. 1997).

STATUS OF THE SPECIES UNDER THE ENVIRONMENTAL BASELINE

To qualify for listing as a threatened species, Ozette Lake sockeye salmon must constitute "species" under the ESA. The ESA defines a "species" to include "any subspecies of fish, wildlife, or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature." On November 20, 1991, NOAA Fisheries published a policy (56 FR 58612) describing the agency's application of the ESA definition of "species" to Pacific salmonid species. This policy provides that a Pacific salmonid population will be

Figure 1. Location and geographic boundaries of the Ozette Lake Sockeye Salmon ESU.



considered distinct, and hence a species under the ESA, if it represents an ESU of the biological species. The population must satisfy two criteria to be considered an ESU: (1) It must be reproductively isolated from other conspecific population units, and (2) it must represent an important component in the evolutionary legacy of the biological species. The first criterion, reproductive isolation, need not be absolute, but must be strong enough to permit evolutionarily important differences to accrue in different population units. The second criterion would be met if the population contributed substantially to the ecological/genetic diversity of the species as a whole. Further guidance on the application of this policy is contained in "Pacific salmon (*Oncorhynchus* spp.) and the Definition of Species under the ESA" (Waples, 1991) and a NOAA Technical Memorandum "Definition of 'Species' Under the Endangered Species Act: Application to Pacific Salmon" (NOAA Fisheries F/NWC-1994).

Status of Ozette Lake sockeye salmon

On March 25, 1999, NOAA Fisheries listed Ozette Lake sockeye salmon ESU, as a threatened species. The ESU includes all naturally spawned populations of sockeye salmon in Ozette Lake and streams and tributaries flowing into Ozette Lake, Washington (64 FR 14528). The Ozette Lake sockeye salmon were listed as threatened under the ESA because NOAA Fisheries determined that a number of factors—both environmental and demographic—had caused them to decline to the point where within the foreseeable future they were likely to be in danger of going extinct. These factors for decline affect their biological requirements at every stage of their lives and they arise from a number of different sources. This section of the Opinion explores those effects and defines the context within which they take place and provides information about their current status.

Life History of Sockeye Salmon

Sockeye salmon exhibit a wide variety of life history patterns that reflect varying dependency on the freshwater environment. With the exception of certain river-type and sea-type populations, the vast majority of sockeye salmon spawn in or near lakes, where the juveniles rear for 1 to 3 years prior to migrating to sea. For this reason, the major distribution and abundance of large sockeye salmon stocks are closely related to the location of rivers that have accessible lakes in their watersheds for juvenile rearing (Burgner 1991). On the Pacific coast, sockeye salmon inhabit riverine, marine, and lake environments from the Columbia River and its tributaries north and west to the Kuskokwim River in western Alaska (Burgner 1991). There are also *O. nerka* life forms that are non-anadromous known as kokanee. Occasionally, a proportion of the juveniles in an anadromous sockeye salmon population will remain in their rearing lake environment throughout life and will be observed on the spawning grounds together with anadromous *O. nerka*. Ricker (1938) defined the terms ``residual sockeye'' and ``residuals'' to identify these resident, non-migratory progeny of anadromous sockeye salmon parents.

Among the Pacific salmon, sockeye salmon exhibit the greatest diversity in selection of spawning habitat and great variation in river entry timing and the duration of holding in lakes prior to spawning. The vast majority of sockeye salmon typically spawn in inlet or outlet tributaries of lakes or along the shoreline of lakes where upwelling of oxygenated water through gravel or sand occurs. However, they may also spawn in (1) suitable stream habitat between lakes, (2) along the nursery lakeshore on outwash fans of tributaries or where upwelling occurs along submerged beaches, and (3) along beaches where the gravel or rocky substrate is free of fine sediment and the eggs can be oxygenated by wind-driven water circulation. All of these spawning habitats may be used by these “lake-type” sockeye salmon.

Growth influences the duration of stay in the nursery lake and is influenced by intra- and interspecific competition, food supply, water temperature, thermal stratification, migratory movements to avoid predation, lake turbidity, and length of the growing season. Lake residence time usually increases the farther north a nursery lake is located. In Washington and British Columbia, lake residence is normally 1 or 2 years, whereas in Alaska some fish may remain 3 or, rarely, 4 years in the nursery lake, prior to smoltification (Burgner 1991, Halupka et al. 1993).

Adaptation to a greater degree of utilization of lake environments for both adult spawning and juvenile rearing has resulted in the evolution of complex timing for incubation, fry emergence, spawning, and adult lake entry that often involves intricate patterns of adult and juvenile migration and orientation not seen in other *Oncorhynchus* species (Burgner 1991).

Upon emergence from the substrate, sockeye salmon alevins exhibit a varied behavior that appears to reflect local adaptations to spawning and rearing habitat. For example, lake-type sockeye salmon juveniles move either downstream or upstream to rearing lakes. Periods of streambank holding are limited for most juvenile sockeye salmon, as emergents in streams above or between connecting lakes use the current to travel to the nursery lake. Predation on migrating sockeye salmon fry varies considerably with spawning location (lakeshore beach, creek, river, or spring area). Sockeye salmon fry mortality due to predation by other fish species and birds can be extensive during downstream and upstream migration to nursery lake habitat and is only partially reduced by the nocturnal migratory movement of some fry populations (Burgner 1991). Juveniles emerging in streams downstream from a nursery lake can experience periods of particularly high predation compared with other juvenile sockeye. Juvenile sockeye salmon in lakes are visual predators, feeding on zooplankton and insect larvae (Foerster 1968, Burgner 1991). Smolt migration typically occurs between sunset and sunrise, beginning in late April and extending through early July, with southern stocks migrating the earliest.

Sockeye salmon also spawn in mainstem rivers without juvenile lake-rearing habitat (Foerster 1968, Burgner 1991). These are referred to as ``river-type'' and ``sea-type'' sockeye salmon. In areas where lake-rearing habitat is unavailable or inaccessible, sockeye salmon may utilize river and estuarine habitat for rearing or may forgo an extended freshwater rearing period and migrate to sea as underyearlings (Birtwell et al. 1987, Wood et al. 1987; Heifitz et al. 1989, Murphy et al.; 1988, 1989, and 1991; Lorenz and Eiler 1989; Eiler et al. 1992; and Wood 1995). Riverine spawners that rear in rivers for 1 or 2 years are termed ``river-type'' sockeye salmon. Riverine spawners that migrate as fry to sea or to lower river estuaries in the same year, following a brief freshwater rearing period of only a few months, are referred to as ``sea-type'' sockeye salmon. River-type and sea-type sockeye salmon are common in northern areas and may predominate over lake-type sockeye salmon in some river systems (Wood et al. 1987, Eiler et al. 1988, Halupka et al. 1993, and Wood 1995).

Once in the ocean, sockeye salmon feed on copepods, euphausiids, amphipods, crustacean larvae, fish larvae, squid, and pteropods. The greatest increase in length is typically in the first year of ocean life, whereas the greatest increase in weight is during the second year. Northward migration of juveniles to the Gulf of Alaska occurs in a band relatively close to shore, and offshore movement of juveniles occurs in late autumn or winter. Among other Pacific salmon, sockeye salmon prefer cooler ocean conditions (Burgner 1991). Lake- or river-type will spend from 1 to 4 years in the ocean before returning to freshwater to spawn.

Adult sockeye salmon home precisely to their natal stream or lake habitat (Hanamura 1966, Quinn 1985, and Quinn et al. 1987). Stream fidelity in sockeye salmon is thought to be adaptive, since this ensures that juveniles will encounter a suitable nursery lake. Wood (1995) inferred from protein electrophoresis data that river- and sea-type sockeye salmon have higher straying rates within river systems than lake-type sockeye salmon.

Ozette Lake sockeye salmon Life History

Adult Ozette Lake sockeye salmon enter Ozette Lake through the Ozette River from April to early August, holding three to nine months in Ozette Lake prior to spawning in late October through January. Sockeye salmon spawn primarily in lakeshore upwelling areas in Ozette Lake (particularly at Allen's Bay and Olsen's Beach). Minor spawning may occur below Ozette Lake in the Ozette River or in Coal Creek, a tributary of the Ozette River. Sockeye salmon do not presently spawn in tributary streams to Ozette Lake, although they may have spawned there historically. Eggs and alevins remain in gravel redds until the fish emerge as fry in spring. Fry then migrate immediately to the limnetic zone in Ozette Lake, where the fish rear. After one year of rearing, in late spring, Ozette Lake sockeye salmon emigrate seaward as age-1+ smolts. The majority of Ozette Lake sockeye salmon return to spawn as four year old adult fish, having spent one winter in fresh water and two winters at sea.

Overview—Status of the Ozette Lake Sockeye Salmon

To determine a species' status under extant conditions (usually termed "the environmental baseline"), it is necessary to ascertain the degree to which the species' biological requirements are being met at that time and in that action area. For the purposes of this consultation, Ozette Lake sockeye salmon's biological requirements are expressed in two ways: population parameters such as fish numbers, distribution, and trends throughout the action area; and the condition of various essential habitat features such as water quality, substrate condition, and food availability. Clearly, these two types of information are interrelated; the condition of a given habitat has a great deal of impact on the number of fish it can support. Nonetheless, it is useful to separate the species' biological requirements into these parameters because doing so is a good way to get a full picture of all the factors affecting Ozette Lake sockeye salmon survival and the response to those factors. Therefore, the discussion to follow will be divided into two parts: (1) Species Distribution and Trends and (2) Factors Affecting the Environmental Baseline.

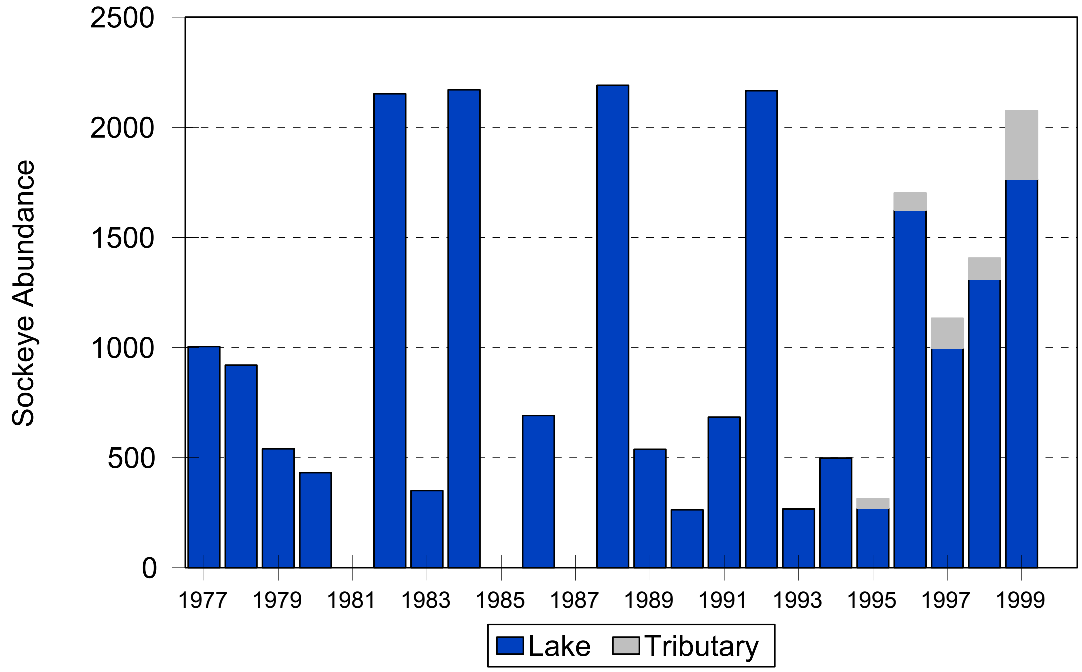
Ozette Lake sockeye salmon Distribution and Trends

The major abundance data series for Ozette River sockeye salmon consist of escapement estimates derived from counts at a weir located at the outlet of Ozette Lake. Counting has occurred in most years since 1977 (Dlugokenski et al. 1981, WDF et al. 1993). The most recent (1992-1996) 5-year average annual escapement for this ESU was about 700. Historical estimates indicate run sizes of a few thousand sockeye salmon in 1926 (Rounsefell and Kelez 1938), with a peak recorded harvest of nearly 18,000 in 1949 (WDF 1974). Subsequently, commercial harvest declined steeply to only a few hundred fish in the mid-1960s and was ended in 1974. A small ceremonial and subsistence fishery continued up until 1981 (Dlugokenski et al. 1981); there has been no direct fishery on this stock since 1982 (WDF et al. 1993). Assuming that Ozette River harvest consisted of sockeye salmon destined to spawn in this system, comparison of these estimates indicates that recent abundance is substantially below the historical abundance range for this ESU.

Harvest of sockeye salmon in the Ozette River fluctuated considerably over time, which would indicate similar fluctuations in spawner abundance if harvest rates were fairly constant. Based on the full weir-count series (1977-1995), abundance has decreased by an average of about 3 percent per year; for the 1986-1995 period, the decrease averaged 10 percent per year. However, in recent years the stock has exhibited dominance by a single brood cycle returning every 4 years (1984, 1988, 1992, 1996), and this dominant cycle has remained stable between 1,700 and 2,200 adults; declines are apparent only in the smaller returns during off-cycle years.

Estimates of annual adult sockeye salmon escapement into Ozette Lake are presented in Figure 2 (data from Makah, 2000). The annual proportions of sockeye salmon estimated to be of lake and tributary-origin are indicated. The 1977-99 average annual abundance level for the total Ozette Lake sockeye return was 1,075 (range 263 to 2,191; excludes 1981, 1985, and 1987 due to lack of data). The most recent four year annual mean run size from 1996 to 1999 for this predominately four-year-old age at return population was 1,598 adults (range 1,133 to 2,076; Makah 2000). The 1996-99 mean lake escapements for beach-origin and tributary-origin

Figure 2. Estimated annual lake and tributary-origin adult sockeye salmon escapement levels into Ozette Lake for 1977 through 1999 (data from Makah, 2000).



sockeye were 1,424 and 156, respectively. Sockeye salmon originating from Ozette Lake tributaries comprised an average of 9.8 % of the total escapement in recent years.

The escapement data presented in Figure 2 consists of annual lake entry estimates for 1977 through 1999 derived from adult sockeye salmon counts at a weir located in the Ozette River at the outlet of Ozette Lake (from Makah, 2000). Included in the figure are annual sockeye salmon run size estimates published in Jacobs et al. (1996) for the period 1988 to 1996 and Makah (2000) for the period 1997 to 1999.

It is possible to make only rough estimates of the number of adults and juveniles in this ESU during the coming five years. Using previous years' estimates noted above, it is likely that future adult returns will number in the thousands of adult fish if conditions remain similar to those of recent years. While we currently lack data on sockeye salmon production for this ESU, it is possible to make rough estimates of juvenile abundance from adult return data. Assuming a recent year (1996-1999) average beach spawner population estimate of 1,424 fish, an average fecundity of 3,097 eggs (1986-98 average), and a deposited egg to swim-up fry survival rate on the beaches of 10%, recent annual production from beach spawners may be estimated to be 220,500 fry. Assuming the same parameters for tributary spawners, 24,150 fry could have resulted from natural spawning in Ozette Lake tributaries. Current fry to smolt survival rates in the lake for these natural-origin fry are unknown.

Factors Affecting the Environmental Baseline

Environmental baselines for biological opinions are defined by regulation at 50 CFR 402.02, which states that an environmental baseline is the physical result of all past and present state, Federal, and private activities in the action area along with the anticipated impacts of all proposed Federal projects in the action area (that have already undergone formal or early section 7 consultation). The environmental baseline for *this* biological opinion is therefore the result of the impacts that many activities (summarized below) have had on Ozette Lake sockeye salmon's survival and recovery. The baseline is the culmination of these effects on these species' *biological requirements* and, by examining those individual effects, it is possible to derive the species' status in the action area.

The biological requirements for Ozette Lake sockeye salmon in the action area can best be expressed in terms of the essential features of their habitat. That is, the salmon require adequate: (1) substrate (especially spawning gravel), (2) water quality, (3) water quantity, (4) water temperature, (5) water velocity, (6) cover/shelter, (7) food, (8) riparian vegetation, (9) space, and (10) migration conditions (65 FR 7764). The best scientific information presently available demonstrates that a multitude of factors, past and present, have contributed to the decline of west coast salmonids by adversely affecting these essential habitat features.

Several potential factors contributing to Ozette sockeye decline have been investigated. Factors such as water quality, Ozette sockeye physical and intra- and inter-specific competition appear not to be contributing to the sockeye declines (Adkinson and Burgner 1996, Geiger 1996, Jacobs et al. 1996). However, other factors such as predation by birds, seals and other marine mammals; introduced non-native diseases or parasites; loss of tributary populations; decline in quality of beach-spawning habitat; historical over-fishing; poor marine survival; excess logging; potential genetic effects of present hatchery production and past interbreeding with genetically dissimilar kokanee; and the synergistic cumulative effects of these factors remain potential explanations for the declines (Beauchamp et al. 1995*,* Adkinson and Burgner 1996, Geiger 1996, Jacobs et al. 1996, Lestelle 1996, Makah Fisheries Management (MFM) 2000/2001). In the tributaries and on certain lake beaches, these factors are believed to have resulted in extirpation of locally adapted spawning aggregations and life history strategies necessary for successful spawning. The review of these factors is summarized in the sections below.

Human-Induced Habitat Degradation

Approximately 80% of the lands surrounding Ozette Basin have been logged. Past timber harvesting practices have eliminated large trees, logs, and other woody debris from many areas in the Ozette basin. Historically, riparian areas within the basin were dominated by old growth

Sitka spruce, Douglas fir, western hemlock, and western red cedar stands. Nearly all of these riparian stands have been clear-cut logged, and are currently in early stages of succession. In previous assessments, Nehlsen et al. (1991) identified logging and road building in the 1940s and 1950s and road building as major causes of the decline of Ozette Lake sockeye salmon.

Consequently, these practices have diminished the frequency and volume of large woody debris (LWD) within tributary channels subsequently influencing channel morphology by (1) affecting longitudinal profile, (2) pool formation, (3) channel pattern and position, and (4) channel geometry (Bisson et al. 1987). LWD also helps control downstream sediment and organic matter transport rates (Beschta 1979). LWD affects the formation and distribution of habitat units, provides cover and complexity, and acts as a substrate for biological activity (Bisson et al. 1987; Sedell and Maser 1994; Swanson et al. 1976). This loss in the basin has contributed to hydrologic changes and sedimentation of key portions of lake tributaries, spawning beaches, and outwash fans. These changes have been identified as major causes for declining sockeye salmon abundance and has contributed to the failure of Ozette Lake sockeye salmon populations to rebuild since the cessation of commercial sockeye salmon harvests in the region in 1974 (64 FR 14528). The following discussion details the effects of hydrologic changes and sedimentation on Ozette lake sockeye.

The loss of large woody debris (LWD) and the removal of logjams from the Ozette and Big rivers in the 1950s (Kramer 1953) have contributed to more abrupt fluctuations in lake level. Research has indicated that lake level fluctuations have historically been large enough to de-water redds and may have also resulted in eggs being deposited outside of their habitable range during extreme fluctuations (Cykler-Ignac 2001). Lake level fluctuations may have also reduced wave energy on the shorelines, resulting in altered particle size distribution along the longitudinal axis of the beach, decreased gravel-cleaning in beach-spawning areas, and increased fine sediment deposition and plant growth. Increased levels of fine sediment are also responsible for a myriad of other tributary and lake habitat impacts, including pool filling and embedding and cementing of spawning substrate. Moreover, because of the depressed abundance of the beach spawning adult sockeye salmon aggregation, annual natural gravel cleaning is expected to reduce (e.g., Montgomery et al. 1996). Sedimentation and hydrologic changes have likely fostered the growth of native willow and sedge species as well as exotic reed canary grass and other shoreline pioneering vegetation, which further increase sedimentation.

Recent data collected by the Makah Tribe indicates high levels of fine sediment (<0.85 mm) within spawning gravels of Ozette Lake tributaries, averaging 17.1% of core samples (MFM, unpublished data). Sediments smaller than 0.85 mm in concentrations greater than 11% (by volume) have been found to decrease survival of salmonid eggs and alevins within gravels (Peterson et al. 1992). McHenry et al. (1994) found that fine sediments (<0.85 mm) at concentrations >13% resulted in intragravel mortality of salmonid embryos due to oxygen stress and metabolic waste build-up. All of these impacts attached with sedimentation are detrimental to salmon productivity.

Other Factors and Efforts to Address Them

Human activities have adverse effects on salmon habitat beyond the ones listed above. Various activites such as boating, fishing, off-road vehicle use, and livestock movement can disrupt salmon behavior damage salmon redds, and so forth. Essentially, any human-caused disturbance in salmon country can, and has, affected salmon to some degree. The cumulative impacts of these activities and the ones listed above have been enormous throughout the range of Ozette Lake sockeye salmon.

Hatcheries

The release of 14,398 kokanee/sockeye salmon hybrids in 1991-1992 (MFM 2000, Natural Resource Consultants (NRC) 1995) may have had deleterious effects on genetic integrity of the ESU because Ozette Lake kokanee are genetically dissimilar to Ozette Lake sockeye salmon. Other concerns include past interbreeding with genetically dissimilar kokanee. Artificial propagation has not been extensive in this basin, but many of the releases have been non-indigenous stocks (Grandy Creek stock) which were reared at the Quilcene National Fish Hatchery before transfer to Ozette Lake (Kemmerich 1945, Boomer 1995, NRC 1995). Genetic effects of these introductions are unknown. Recent hatchery production in Ozette Lake has been primarily from Ozette Lake stock (NRC 1995), with the exception of 120,000 Quinault Lake sockeye salmon juveniles released in 1983.

NOAA Fisheries has identified four primary ways hatcheries harm naturally-produced salmon: (1) ecological effects, (2) genetic effects, (3) overharvest effects, and (4) masking effects (NMFS 2000a). Ecologically, hatchery fish can prey upon, displace, and compete with naturally-produced fish. These effects are most likely to occur when hatchery fish are released in poor condition and do not migrate to marine waters, but rather remain in the streams for extended rearing periods. Hatchery fish also may transmit hatchery-borne diseases, and hatcheries themselves may release disease-carrying effluent into streams. Hatchery effluents may also change water temperature, pH, suspended solids, ammonia, organic nitrogen, total phosphorus, and chemical oxygen demand in the receiving stream’s mixing zone (Kendra 1991). Hatchery fish can affect the genetic variability of native fish by interbreeding with them, though interbreeding can also result from the introduction of native stocks from other areas. Theoretically, interbred fish are less adapted to the local habitats where the original native stock evolved and are therefore less productive there.

In many areas, hatchery fish provide increased fishing opportunities. However, when naturally-produced fish mix with hatchery stock in these areas, smaller or weaker naturally-produced stocks can be overharvested. Moreover, when migrating adult hatchery and naturally-produced fish mix on the spawning grounds, the health of the naturally-produced runs and the habitat's ability to support them can be overestimated because the hatchery fish mask the surveyors' ability to discern actual naturally-produced run conditions.

To address concerns of potential disease transmission from hatchery salmonids and to minimize water quality impacts, comanagers developed a Pacific Northwest Fish Health Protection Committee (1989) and are in compliance with the National Pollutant Discharge Elimination System permit provisions and Pacific Northwest Fish Health Protection Committee's comprehensive fish health protection program.

Harvest

Lake Ozette supported a fishery by the Makah Indian Tribe that yielded over 17,500 fish in 1949 and approximately 15,000 sockeye in both 1950 and 1951, but subsequently declined to zero in both 1974 and 1975 (Blum 1984). In recent years the Lake Ozette fishery has averaged only about 30 fish per year (Blum 1984). Harvest has not been an important mortality factor for the population in over 35 years. In addition, due to the early river entry timing of returning Ozette Lake sockeye salmon (beginning in late-April, with peak returns prior to late-May or mid-June), the fish are not intercepted in Canadian and U.S. marine area fisheries directed at Fraser River sockeye salmon. There are currently no known marine area harvest impacts on Ozette Lake sockeye salmon.

Restoration of the Lake Ozette sockeye fishery will be attempted through the use of an introduced sockeye stock that will utilize the lake's tributaries to spawn. The native stock only utilizes the suitable part of the lake shore, which is currently extremely limited in area (Blum 1984). There are no plans to initiate fisheries that indirectly or directly harvest listed Ozette Lake sockeye salmon until the population has recovered, and until escapement goals needed to sustain natural spawning aggregations in the Basin are identified.

Natural Conditions

Recent studies indicate that predation rates by marine mammals may be an important limiting factor to the listed sockeye salmon population (NMFS 1997; Makah and NMFS MML 2000). Preliminary harbor seal and river otter predation studies (Makah 2000; NMFS 2000b), and actual sockeye salmon spawner census data for beach and tributary spawning areas (Makah 2000), indicate that pre-spawning sockeye salmon mortality during the lake-holding period prior to spawning (ranging up to nine months) is an important factor. Harbor seal predation on sockeye salmon in beach spawning areas appears to be significant (Makah and NMFS MML 2000; K.M. pers. comm. cited in NMFS 2002).

In addition to predation by marine mammals, Beauchamp et. al. (1995) reported that cutthroat trout *(O. clarki)* and northern pikeminnow *(Ptychocheilus oregonensis)* predation could be a limiting factor over the current and future production of Ozette Lake sockeye salmon. Cutthroat trout have been observed to consume large numbers of eggs on spawning beaches (Dlugokenski et al. 1981; MFM unpublished field notes, 2000). Beauchamp et al. (1995) estimated that for every 1,000 cutthroat trout greater than 300 mm, 138,900 age-0 and 27,000 age-1 *O.* nerka were consumed. Biomass estimates of cutthroat trout have not been made in Ozette Lake, although Beauchamp et al. (1995) speculated that the population of large cutthroat was between 5,000 and 10,000 fish.

Beauchamp et al. (1995) found that for every 1,000 northern pikeminnow exceeding 300 mm, 5,600 sub-yearling sockeye salmon and kokanee may be consumed per year. Large numbers of northern pikeminnow were observed transiting the Ozette River during the sockeye salmon smolt emigration period in recent years, and northern pikeminnow have been observed preying on salmon smolts in the vicinity of the adult counting weir in the Ozette River (MFM unpublished data). As with cutthroat trout, predation impacts by northern pikeminnow on Ozette Lake sockeye abundance remain unknown, due to the lack of abundance biomass estimates for these species.

Ocean predation may also contribute significantly to natural mortality, although it is not known to what degree. Because of the precarious status of the Ozette Lake sockeye salmon (i.e., the decline in sockeye productivity, historical over-harvesting, and excess logging), natural predation may potentially be affecting the status and recovery of these populations.

Changes in climate and ocean conditions happen on several different time scales and have had profound influence on distributions and abundances of marine and anadromous fishes. Recent evidence suggests that marine survival among salmonids fluctuates in response to 20- to 30-year cycles of climatic conditions and ocean productivity (Hare et al. 1999). This phenomenon is referred to as the Pacific Decadal Oscillation (PDO). Although recent climatic conditions appear to be within the range of historical conditions, the risks associated with climatic changes are probably exacerbated by human activities (Lawson 1993). Recent declines in fish populations in the Pacific northwest may reflect these recent climatic shifts. The phenomenon can have a substantial effect on the growth and survival of salmon during their migrations and feeding in the north Pacific Ocean and can also have a major influence on the freshwater environment in Washington State (WDFW/PNPT 2000). Francis and Hare (1997) demonstrated that the PDO regime shifts influenced the abundance of zooplankton and subsequent salmon production in the North Pacific Ocean, potentially affecting the survival of salmon.

Large-scale climatic regime shifts such as El Niño-Southern Oscillation events also appear to change ocean productivity. The effects of these warm water intrusions are felt along the Washington and British Columbia coast for a one to two year duration in an irregular periodicity of every two to seven years (Mysak 1986). During the first part of the 1990s, much of the

Pacific Coast was subject to a series of very dry years. These episodes vary in intensity and have affected salmonid marine growth and survival by impacting food abundance, predator interaction, and the freshwater environment.

A key factor affecting many West Coast stocks has been a general 30-year decline in ocean productivity. The mechanism whereby stocks are affected is not well understood, partially because the pattern of response to these changing ocean conditions has differed among stocks—presumably due to differences in their ocean timing and distribution. It is assumed that survival is driven largely by events occurring between ocean entry and recruitment to a subadult life stage. One indicator of early ocean survival can be computed as a ratio of coded wire tags (CWT) recoveries from subadults relative to the number of CWTs released from that brood year. Time-series of survival rate information for Skagit River fall chinook salmon show highly variable or declining trends in early ocean survival, with very low survival rates in recent years (NMFS 1999c).

Finally, the unusual drought conditions in 2001 warrant consideration. The available water in the Pacific northwest's lakes and rivers was below normal and resulted in some of the lowest flow conditions on record. The juveniles that emigrated during the 2001 spring and summer out-migration will likely be affected and this, in turn, will affect adult returns—primarily in 2003 and 2004. At this time, it is impossible to ascertain what those effects will be, but NOAA Fisheries is carefully monitoring the situation and will take the drought condition into account in any management decision, including amending take authorizations and other permit conditions.

Scientific Research

Ozette Lake sockeye, like other ESA-listed fish, are the subject of scientific research and monitoring activities. Most biological opinions issued by NOAA Fisheries have conditions requiring specific monitoring, evaluation, and research projects to gather information to aid the survival of listed fish. In addition, NOAA Fisheries has issued numerous research permits authorizing takes of ESA-listed fish over the last few years; however, this is the first biological opinion addressing Ozette Lake sockeye research authorization. The effect of the research described in this opinion is difficult to assess because despite the fact that fish are harassed and even killed in the course of scientific research, these activities have a great potential to benefit ESA-listed species. For example, aside from simply increasing what is known about the listed species and their biological requirements, research is essentially the only way to answer key questions associated with difficult resource issues that crop up in every management arena and involve every salmonid life history stage (particularly the resource issues discussed in the previous sections). Most important, the information gained during research and monitoring activities will help resource managers plan for the recovery of listed species. That is, no rational resource allocation or management decisions can be made without the knowledge to back them up. Further, there is no way to tell if the corrective measures described in the previous sections are working unless they are monitored, and there is no way to design new and better approaches if research is not done.

In any case, scientific research and monitoring efforts (unlike the other factors described in the previous sections) are not considered to be a factor contributing to the decline of Ozette Lake sockeye salmon, and NOAA Fisheries believes that the information derived from the research activities is essential to their survival and recovery. Nonetheless, fish *are* harmed during research activities and activities that are carried out in a careless or undirected fashion are not likely to benefit the species at all. Therefore, to minimize any harm arising from research activities on the species, NOAA Fisheries imposes conditions in its permits so that permit holders reduce adverse effects on the ESA-listed species, including keeping mortalities as low as possible. Researchers are encouraged to use non-listed fish species and hatchery fish instead of listed naturally-produced fish when possible. Also, researchers are required to share sampled fish, as well as the results of the scientific research, with other researchers and comanagers in the region as a way to avoid duplicative research efforts and to acquire as much information as possible from the ESA-listed fish sampled. NOAA Fisheries also works with other agencies to coordinate research and thereby prevent duplication of effort.

For projects that require an ESA section 10(a)(1)(A) permit, applicants provide NOAA Fisheries with high take estimates to compensate for potential in-season changes in research protocols, accidental catastrophic events, and the annual variability in listed fish numbers. Also, most research projects depend on annual funding and the availability of other resources. So, a specific research project for which take of ESA-listed species is authorized by a permit may be suspended in a year when funding or resources are not available. As a result, the *actual* take in a given year for most research projects, as provided to NOAA Fisheries in post-season annual reports, is usually less than the authorized level of take in the permits and the related NOAA Fisheries consultation on the issuance of those permits. Therefore, because actual take levels tend to be lower than authorized takes, the severity of effects to the ESA-listed species to result from the conduct of scientific research activities are usually less than the effects analyzed in a typical research permit consultation.

Summary

The picture of whether Ozette Lake sockeye salmon's biological requirements are being met is clear-cut for habitat-related parameters and for population factors; given all the factors for decline—even taking into account the corrective measures being implemented or proposed[1]—it is clear that their biological requirements are currently not being met under the environmental

---

[1] Please see the following document for a summary of implemented and proposed conservation efforts: Lake Ozette Sockeye Salmon Resource Management Plan-Hatchery and Genetic Management Plan Component, (NMFS, unpubl. manusc.).

baseline. Their status is such that there must be a significant improvement in the environmental conditions of the species' respective habitats (over those currently available under the environmental baselines). Any further degradation of the environmental conditions would have a significant impact due to the amount of risk the species presently faces under the environmental baselines. In addition, there must be considerable improvements to minimize effects due to habitat degradation, predation, hatchery practices, and unfavorable marine conditions.

EFFECTS OF THE ACTION

The purpose of this section is to identify the effects NOAA Fisheries' issuance of scientific research permits will have on threatened Ozette Lake sockeye salmon. To the extent possible, this will include analyses of effects at the population level. Where information on Ozette Lake sockeye salmon is scarce at the population level, this analysis assumes that the status of each affected population is the same as the ESU as a whole. Analyses of effects will not include hatchery stocks because NOAA Fisheries considers these stocks nonessential to the ESU's recovery.

Evaluating the Effects of the Action

Over the course of several years and numerous ESA section 7 consultations, NOAA Fisheries developed the following four-step approach for using the ESA Section 7(a)(2) standards to determine what effect a proposed action is likely to have on a given listed species. What follows here is a summary of that approach.[2]

1. Define the biological requirements and current status of each listed species.

2. Evaluate the relevance of the environmental baseline to the species' current status.

3. Determine the effects of the proposed or continuing action on listed species and their habitat.

4. Determine whether the species can be expected to survive with an adequate potential for recovery under (a) the effects of the proposed (or continuing) action, (b) the effects of the environmental baseline, and (c) any cumulative effects—including all measures being taken to improve salmonid survival and recovery.

---

[2] For more detail please see pages 4-10 of *The Habitat Approach: Implementation of Section 7 of the Endangered Species Act for Actions Affecting the Habitat of Pacific Salmonids* (NMFS 1999e).

The fourth step above requires a two-part analysis. The first part focuses on the action area and defines the proposed action's effects in terms of the species' biological requirements in that area (i.e., impacts on essential habitat features). The second part focuses on the species itself. It describes the action's impact on individual fish—or populations, or both—and places that impact in the context of the ESU as a whole. Ultimately, the analysis seeks to answer the questions of whether the proposed action is likely to jeopardize a listed species' continued existence or destroy or adversely modify its habitat.

Effects on Ozette Lake Sockeye Salmon Habitat

Previous sections have described the essential features of Ozette Lake sockeye habitat, and depicted its present condition. The discussion here focuses on how those features are likely to be affected by the proposed actions.

Full descriptions of the proposed activities are found in the next section. In general, the activities will be boat electrofishing and capturing fish with angling equipment, traps, and nets of various types. All of these techniques are minimally intrusive in terms of their effect on habitat. None of them will measurably affect any of the 10 essential fish habitat features listed earlier (i.e., stream substrates, water quality, water quantity, food, streamside vegetation, etc.). Moreover, the proposed activities are all of short duration. Therefore, NOAA Fisheries concludes that the proposed activities are unlikely to adversely modify Ozette Lake sockeye salmon habitat.

Effects on Ozette Lake Sockeye Salmon

The primary effects the proposed activities will have on Ozette Lake sockeye salmon will be in the form of direct "take" (the ESA take definition is given in the section introducing the individual permits) usually in the form of harassment. Harassment generally leads to stress and other sub-lethal effects and is caused by observing, capturing, and handling fish. The ESA does not define harassment nor has NOAA Fisheries defined this term through regulation. However, the USFWS defines harassment as "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to breeding, feeding or sheltering" [50 CFR 17.4]. For the purposes of this analysis, NOAA Fisheries adopts this definition of harassment.

While the difference between what constitutes an activity (e.g., electrofishing) and what constitutes a take category (e.g., harm) is not always clear, it is important to keep the two concepts separate. The reason for this is that the effects being measured here are those which the activity itself has on the listed species. They may be expressed in *terms* of the take categories (e.g., how many Ozette Lake sockeye salmon are harmed, or harassed, or even killed), but the actual mechanisms of the effects themselves (i.e., the activities) are the causes of whatever take arises and, as such, they bear examination. Therefore, the first part of this section is devoted to a discussion of the general effects known to be caused by the proposed activities, regardless of where they occur or what species are involved.

The following subsections constitute a comprehensive list of the types of activities being proposed. Because they would all be carried out by trained professionals using established protocols and have widely recognized specific impacts, each description is broadly applicable to every proposed permit. Researchers do not receive a permit unless their activities (e.g., electrofishing) incorporate NOAA Fisheries' uniform, pre-established set of mitigation measures.

Capture/handling

Capturing and handling fish causes them stress—though they typically recover fairly rapidly from the process and therefore the overall effects of the procedure are generally short-lived. The primary contributing factors to stress and death from handling are excessive doses of anesthetic, differences in water temperatures (between the river and wherever the fish are held), dissolved oxygen conditions, the amount of time that fish are held out of the water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 18°C or dissolved oxygen is below saturation. Fish that are transferred to holding tanks can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps if the traps are not emptied on a regular basis. Debris buildup at traps can also kill or injure fish if the traps are not monitored and cleared on a regular basis.

Based on prior experience with the research techniques and protocols that would be used to conduct the proposed scientific research, no more than five percent of the juvenile salmonids encountered are likely to be killed as an indirect result of being captured and handled and, in most cases, that figure will not exceed three percent. In addition, it is not expected that more than one percent of the adults being handled will die. In any case, all researchers will follow the mitigation measures described earlier (page 3) and thereby keep adverse effects to a minimum. Finally, any fish indirectly killed by the research activities in the proposed permits may be retained as reference specimens or used for other research purposes.

Electrofishing

Electrofishing is a process by which an electrical current is passed through water containing fish in order to stun them—thus making them easy to capture. It can cause a suite of effects ranging form simple harassment to actually killing the fish. The amount of unintentional mortality attributable to electrofishing may vary widely depending on the equipment used, the settings on the equipment, and the expertise of the technician. Electrofishing can have severe effects on adult salmonids. Spinal injuries in adult salmonids from forced muscle contraction have been documented. Sharber and Carothers (1988) reported that electrofishing killed 50 percent of the adult rainbow trout in their study. The long-term effects electrofishing has on both juveniles and adult salmonids are not well understood, but long experience with electrofishing indicates that most impacts occur at the time of sampling and are of relatively short duration.

The effects of electrofishing on Ozette Lake sockeye salmon would be limited to the direct and indirect effects of exposure to an electric field, capture by netting, holding captured fish in aerated tanks, and the effects of handling associated with transferring the fish back to the river (see the previous subsection for more detail on capturing and handling effects). Most of the studies on the effects of electrofishing on fish have been conducted on adult fish greater than 300 mm in length (Dalbey et al. 1996). The relatively few studies that have been conducted on juvenile salmonids indicate that spinal injury rates are substantially lower than they are for large fish. Smaller fish intercept a smaller head-to-tail potential than larger fish (Sharber and Carothers 1988) and may therefore be subject to lower injury rates (e.g., Hollender and Carline 1994, Dalbey et al. 1996, Thompson et al. 1997). McMichael et al. (1998) found a 5.1% injury rate for juvenile MCR steelhead captured by electrofishing in the Yakima River subbasin. The incidence and severity of electrofishing damage is partly related to the type of equipment used and the waveform produced (Sharber and Carothers 1988, McMichael 1993, Dalbey et al. 1996, Dwyer and White 1997). Continuous direct current (DC) or low-frequency (≤30 Hz) pulsed DC have been recommended for electrofishing (Fredenberg 1992, Snyder 1992, 1995, Dalbey et al. 1996) because lower spinal injury rates, particularly in salmonids, occur with these waveforms (Fredenberg 1992, McMichael 1993, Sharber et al. 1994, Dalbey et al. 1996). Only a few recent studies have examined the long-term effects of electrofishing on salmonid survival and growth (Dalbey et al. 1996, Ainslie et al. 1998). These studies indicate that although some of the fish suffer spinal injury, few die as a result. However, severely injured fish grow at slower rates and sometimes they show no growth at all (Dalbey et al. 1996).

NOAA Fisheries' electrofishing guidelines (NMFS 2000c) will be followed in all surveys requiring this procedure. The guidelines require that field crews be trained in observing animals for signs of stress and shown how to adjust electrofishing equipment to minimize that stress. Electrofishing is used only when other survey methods are not feasible. All areas for stream and special needs surveys are visually searched for fish before electrofishing may begin. Electrofishing is not done in the vicinity of redds or spawning adults. All electrofishing equipment operators are trained by qualified personnel to be familiar with equipment handling, settings, maintenance, and safety. Operators work in pairs to increase both the number of fish that may be seen and the ability to identify individual fish without having to net them. Working in pairs also allows the researcher to net fish before they are subjected to higher electrical fields. Only DC units will be used, and the equipment will be regularly maintained to ensure proper operating condition. Voltage, pulse width, and rate will be kept at minimal levels and water conductivity will be tested at the start of every electrofishing session so those minimal levels can be determined. Due to the low settings used, shocked fish normally revive instantaneously. Fish requiring revivification will receive immediate, adequate care.

The preceding discussion focused on the effects of using a backpack unit for electrofishing and the ways those effects will be mitigated. It should be noted, however, that in larger streams and rivers electrofishing units are sometimes mounted on boats. These units often use more current than backpack electrofishing equipment because they need to cover larger (and deeper) areas and, as a result, can have a greater impact on fish. In addition, the environmental conditions in larger, more turbid streams can limit researchers' ability to minimize impacts on fish. For example, in areas of lower visibility it is difficult for researchers to detect the presence of adults and thereby take steps to avoid them. Because of its greater potential to harm fish, and because NOAA Fisheries has not published appropriate guidelines, boat electrofishing has not been given a general authorization under NOAA Fisheries' recent ESA section 4(d) rules. However, it is expected that guidelines for safe boat electrofishing will be in place in the near future. And in any case, all researchers intending to use boat electrofishing will use all means at their disposal to ensure that a minimum number of fish are harmed (these means will include a number of long-established protocols that will eventually be incorporated into NOAA Fisheries' guidelines).

Benefits of Research

Under section 10(d) of the ESA, NOAA Fisheries is prohibited from issuing a section 10(a)(1)(A) permit unless NOAA Fisheries finds that the permit (1) was applied for in good faith; (2) if granted and exercised, will not operate to the disadvantage of the endangered and/or threatened species that is/are the subject of the permit; and (3) is consistent with the purposes and policy of section 2 of the ESA. In addition, NOAA Fisheries does not issue a section 10(a)(1)(A) permit unless the proposed activities are likely to result in a net benefit to the ESA-listed species that is/are the subject of the permit; benefits accrue from the acquisition of scientific information.

For more than a decade, research and monitoring activities conducted with anadromous salmonids in the Pacific Northwest have provided resource managers with a wealth of important and useful information on anadromous fish populations. For example, juvenile fish trapping efforts have enabled the production of population inventories, PIT-tagging efforts have increased the knowledge of anadromous fish migration timing and survival, and fish passage studies have provided an enhanced understanding of fish behavior and survival when moving past dams and through reservoirs. By issuing section 10(a)(1)(A) scientific research permits, NOAA Fisheries will cause information to be acquired that will enhance the ability of resource managers to make more effective and responsible decisions to sustain anadromous salmonid populations that are at risk of extinction, to mitigate impacts to endangered and threatened salmon and steelhead, and to implement recovery efforts. The resulting data for research authorized under permit 1386 will provide potential benefits to endangered and threatened salmon and steelhead through pollution control actions resulting from the program's findings. Pollution control actions may take the form of habitat improvement and/or reduction of toxic contaminants.

Permit Specific Effects

Effects of the proposed activity are discussed in the general effects section. Through permit conditions researchers will use measures discussed previously to mitigate adverse impacts on listed ESUs.

Permit 1386

Permit 1386 would authorize the DOE to capture, handle, and release up to 10 juvenile and two adult Ozette Lake sockeye salmon. The permit would also allow the DOE to kill no more than one juvenile Ozette Lake sockeye salmon as an indirect result of being captured.

NOAA Fisheries estimates an outmigration of approximately 220,500 juvenile, naturally-produced Ozette Lake sockeye salmon. The vast majority (more than 95%) of the Ozette Lake sockeye salmon that will be captured and handled during the course of the proposed research (a total of 11 juvenile and two adult fish) are expected to survive with no long-term effects. Moreover, most capture, handling, and holding methods will be minimally intrusive and of short duration. Because so many of the captured fish are expected to survive the research actions and so few (a maximum of 0.005% of the total juvenile Ozette Lake sockeye salmon outmigration and a maximum of 0.14% of the total adult Ozette Lake sockeye escapement) will be affected in even the slightest way, it is likely that no adverse effects will result from these actions at either the population or the ESU level. Therefore, adverse effects must be expressed in terms of the individual fish that may be killed during the various permitted activities.

If the total amount of estimated lethal take for all research activities—one juvenile Ozette Lake sockeye salmon per year—is expressed as a fraction of the 220,500 fish expected to emigrate from their natal habitat, it represents a loss of 0.0005% of the run. However, and for a number of reasons, that number is probably zero. First, as stated earlier in the Opinion, the anticipated outmigration of Ozette Lake sockeye salmon is a very conservative estimate. Second, it is important to remember to account for potential accidental deaths, that estimates of lethal take for the proposed study has purposefully been inflated and it is therefore very likely that no juveniles will be killed by the research. Third, the study is described as affecting "juveniles," which means they may target Ozette Lake sockeye salmon yearlings, parr, or even fry: life stages represented by many more individuals than reach the smolt stage—perhaps as much as an order of magnitude more. Therefore the 0.0005% figure was derived by (a) underestimating the actual number of outmigrating Ozette Lake sockeye salmon smolts, (b) overestimating the number of fish likely to be killed, and (c) treating each dead Ozette Lake sockeye salmon as a smolt when some of them clearly won't be. Thus the actual number of Ozette Lake sockeye salmon the research is likely to kill is smaller than 0.0005% per year.

But even if the entire 0.0005% of the juvenile Ozette Lake sockeye salmon population were killed, and they were *all* treated as smolts, it would be very difficult to translate that number into an actual effect on the species. Even if the subject were one adult killed out of a population of one thousand it would be hard to resolve an adverse effect. And in this instance, that effect is even smaller because the loss of a smolt is not equivalent to the loss of an adult in terms of species survival and recovery. This is due to the fact that a great many smolts die before they can mature into adults. Therefore the research will have no measurable adverse effect on the ESU.

Cumulative Effects

Cumulative effects include the effects of future state, tribal, local or private actions not involving Federal activities that are reasonably certain to occur within the action area of the Federal action subject to this consultation. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the Act.

State, tribal and local government actions will likely be in the form of legislation, administrative rules or policy initiatives. Government and private actions may include changes in land and water uses, including ownership and intensity, any of which could impact listed species or their habitat. Government actions are subject to political, legislative and fiscal uncertainties. These realities, added to geographic scope of the action area which encompasses numerous government entities exercising various authorities and the many private landholdings, make any analysis of cumulative effects difficult and frankly speculative. This section identifies representative actions that, based on currently available information, are reasonably certain to occur. It also identifies some goals, objectives and proposed plans by government entities. However, NOAA Fisheries is unable to determine at this point in time whether any proposals will in fact result in specific actions.

Representative State Actions

The Washington state government is cooperating with other governments to increase environmental protection for listed ESUs, including better habitat restoration, hatchery and harvest reforms, and water resource management. There are other proposals, rules, policies, initiatives, and government processes that help conserve marine resources in Washington, improve the habitat of listed species, and assist in recovery planning that are too numerous to mention. These programs could benefit the listed species if implemented and sustained.

In the past, Washington state's economy was heavily dependent on natural resources, with intense resource extraction activity. Changes have occurred in the last decade and are likely to continue with less large scale resource extraction, more targeted extraction methods, and significant growth in other economic sectors. Continued impacts affecting habitat features, such as water quality and quantity, which are important to the survival and recovery of the listed species need to be carefully planned for and mitigated through the initiatives and measures described above.

Local Actions

Local governments will be faced with similar but more direct pressures from population pressures. There will be demands for intensified development in rural areas as well as increased demands for water, municipal infrastructure and other resources. The reaction of local governments to such pressures is difficult to assess at this time without certainty in policy and funding. In the past, local governments in the action area generally accommodated additional growth in ways that adversely affected listed fish habitat allowing for development to destroy wetlands, habitat, etc.

Some local government programs, if submitted, may qualify for a limit under the NOAA Fisheries' ESA section 4(d) rule which is designed to conserve listed species. Local governments also may participate in regional watershed health programs, although political will and funding will determine participation and therefore the effect of such actions on listed species. Overall, without comprehensive and cohesive beneficial programs and the sustained application of such programs, it is likely that local actions will have few measurable positive effects on listed species and their habitat, and may even contribute to further degradation.

Tribal Actions

The decline of Ozette Lake sockeye salmon abundance over the past century has prevented the Tribe from conducting any Treaty-reserved sockeye salmon fisheries in the Ozette Lake Basin for almost 20 years. The Makah Tribe intends to rebuild the Ozette Lake sockeye salmon resource to the point where it will again be possible to conduct meaningful, ceremonial, subsistence, and commercial Treaty fisheries in the Ozette Lake Basin. Currently, the Makah Tribal government participates in cooperative efforts involving watershed and basin planning designed to improve fish habitat and is expected to continue to do so.

Private Actions

The lake is located within Olympic National Park, and development of Basin resources for residential and commercial uses is therefore relatively low. However, private timber corporations own the majority of the Ozette Lake watershed (Dlugokenski et al.1981; Figure 1). In addition, Ozette Lake is used by local residents and the National Park Service as a domestic water source (Dlugokenski et al. 1981).

The effects of private actions are the most uncertain. Private landowners may convert current use of their lands, or they may intensify or diminish current uses. Individual landowners may voluntarily initiate actions to improve environmental conditions, or they may abandon or resist any improvement efforts. Their actions may be compelled by new laws, or may result from growth and economic pressures. Changes in ownership patterns will have unknown impacts.

Summary

Non-federal actions on listed species are likely to continue affecting listed species. The cumulative effects in the action area are difficult to analyze considering the geographic landscape of this opinion, the uncertainties associated with government and private actions, and the changing economies of the region. Whether these effects will increase or decrease is a matter of speculation; however, based on the trends identified in this section, the adverse cumulative effects are likely to increase. Although state, Tribal and local governments have developed plans and initiatives to benefit listed fish, they must be applied and sustained in a comprehensive way before NOAA Fisheries can consider them "reasonably foreseeable" in its analysis of cumulative effects.

Conclusion

After reviewing the current status of threatened Ozette Lake sockeye salmon, the environmental baseline for the action area, the effects of the proposed section 10(a)(1)(A) permit action, and cumulative effects, it is NOAA Fisheries' biological opinion that issuance of the proposed permit is not likely to jeopardize the continued existence of threatened Ozette Lake sockeye, nor destroy nor adversely modify their habitat.

Coordination with the National Ocean Service

The activities contemplated in this Biological Opinion will not be conducted in or near a National Marine Sanctuary. Therefore, these activities will not have an adverse effect on any National Marine Sanctuary.

Reinitiation of Consultation

Consultation must be reinitiated if: The amount or extent of annual takes specified in the permits and this consultation is exceeded or is expected to be exceeded; new information reveals effects of the actions that may affect the ESA-listed species in a way not previously considered; a specific action is modified in a way that causes an effect on the ESA-listed species that was not previously considered; or a new species is listed or critical habitat is designated that may be affected by the action (50 CFR 402.16).

MAGNUSON-STEVENS ACT ESSENTIAL FISH HABITAT CONSULTATION

"Essential fish habitat" (EFH) is defined in section 3 of the Magnuson-Stevens Act (MSA) as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." NOAA Fisheries interprets EFH to include aquatic areas and their associated physical, chemical and biological properties used by fish that are necessary to support a sustainable fishery and the contribution of the managed species to a healthy ecosystem.

The MSA and its implementing regulations at 50 CFR 600.920 require a Federal agency to consult with NOAA Fisheries before it authorizes, funds or carries out any action that may adversely effect EFH. The purpose of consultation is to develop a conservation recommendation(s) that addresses all reasonably foreseeable adverse effects to EFH. Further, the action agency must provide a detailed, written response NOAA Fisheries within 30 days after receiving an EFH conservation recommendation. The response must include measures proposed by the agency to avoid, minimize, mitigate, or offset the impact of the activity on EFH. If the response is inconsistent with NOAA Fisheries' conservation recommendation the agency must explain its reasons for not following the recommendations.

The objective of this consultation is to determine whether the proposed actions, the funding and issuance of scientific research permits under section 10(a)(1)(A) of the ESA for activities within the state of Washington, is likely to adversely affect EFH. If the proposed actions are likely to adversely affect EFH, a conservation recommendation(s) will be provided.

Identification of Essential Fish Habitat

The Pacific Fishery Management Council (PFMC) is one of eight Regional Fishery Management Councils established under the Magnuson-Stevens Act. The PFMC develops and carries out fisheries management plans for Pacific coast groundfish, coastal pelagic species and salmon off the coasts of Washington, Oregon and California. Pursuant to the MSA, the PFMC has designated freshwater and marine EFH for several species of Pacific salmon (PFMC 2000). For purposes of this consultation, freshwater EFH for Pacific salmon in Washington includes all streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to Pacific salmon, except areas upstream of certain impassable dams (as identified by PFMC), and longstanding, naturally-impassible barriers (i.e., natural waterfalls in existence for several hundred years) (PFMC 1999). Marine EFH for Pacific salmon in Washington, Oregon and California includes all estuarine, nearshore and marine waters within the western boundary of the U.S. Exclusive Economic Zone (EEZ), 200 miles offshore.

Proposed Action and Action Area

For this EFH consultation the proposed actions and action area are as described in detail in the ESA consultation above. The actions are the funding and issuance of a scientific research permit pursuant to section 10(a)(1)(A) of the ESA. The proposed action area is the Ozette Lake basin, Washington. A more detailed description and identification of EFH for salmon is found in Appendix A to Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999). Assessment of the impacts to these species' EFH from the above proposed action is based on this information.

Effects of the Proposed Action

Based on information submitted by the action agencies and permit applicant, as well as NOAA Fisheries' analysis in the ESA consultation above, NOAA Fisheries believes that the effects of this action on EFH are likely to be within the range of effects considered in the ESA portion of this consultation.

Conclusion

Using the best scientific information available and based on its ESA consultation above, as well as the foregoing EFH sections, NOAA Fisheries has determined that the proposed action is not likely to adversely affect EFH for Pacific salmon

EFH Conservation Recommendation

NOAA Fisheries has no conservation recommendations to make in this instance.

Consultation Renewal

The action agencies must reinitiate EFH consultation if plans for these actions are substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for the EFH conservation recommendations (50 CFR Section 600.920(k)).

References

Federal Register Notices

November 20, 1991 (56 FR 58612). Notice of Policy. Policy on Applying the Definition of Species Under the Endangered Species Act to Pacific Salmon.

February 16, 2000 (65 FR 7764). Final Rule: Designated Critical Habitat: Critical Habitat for 19 Evolutionarily Significant Units of Salmon and Steelhead in Washington, Oregon, Idaho, and California.

March 24, 1999 (64 FR 14528). Final Rule: Threatened Status for Ozette Lake Sockeye Salmon in Washington.

Literature Cited

Adkison, M.D., and R.L. Burgner. 1996. Management and research priorities for Lake Ozette sockeye: a report following the May 8th, 1996 review of population status at the Olympic National Park in Port Angeles, Washington, in *The sockeye salmon Oncorhynchus nerka population in lake Ozette, Washington, USA, Tech. Rep. NPS/CCSOSU/NRTR-96/04*, p. 99-110.

Ainslie, Barbara J., John R. Post, Andrew J. Paul, 1998: Effects of Pulsed and Continuous DC Electrofishing on Juvenile Rainbow Trout. North American Journal of Fisheries Management: Vol. 18, No. 4, pp. 905–918.

Beauchamp, D.A., M.G. LaRiviere, and G.L. Thomas. 1995. Evaluation of competition and predation as limits to juvenile kokanee and sockeye salmon production in Lake Ozette, Washington. North American Journal of Fish Management. 15:193-207.

Birtwell, I. K., M. D. Nassichuk, and H. Buene. 1987. Underyearling sockeye salmon (Oncorhynchus nerka) in the estuary of the Fraser River. Can. Spec. Publ. Fish. Aquat. Sci. 96:25-35.

Blum, J. P. 1984. Management strategies for restoration and rehabilitation of sockeye salmon (Oncorhynchus nerka) in Lake Ozette, Washington. In J. M. Walton and D. B. Houston (editors), Proceedings of the Olympic wild fish conference, p. 55-62. Fisheries Technology Program, Peninsula College, Port Angeles, WA.

Boomer, R. 1995. Letter to R. Gustafson, NMFS, from R. Boomer, Project Leader, Western Washington Fishery Resource Office, Fish and Wildlife Service, re. Quilcene National Fish Hatchery Log Books, 1920-1958, dated 11 May 1995. 1 p. plus attachment. (Available from West Coast Sockeye Salmon Administrative Record, Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N. E. Oregon Street, Portland, OR 97232.)

Bortleson, G.C., and N.P. Dion. 1979. Preferred and observed conditions for salmon in Ozette Lake and its tributaries, Clallam County, Washington. U.S. Geological Survey Water Resources Investigations. 78-64.

Burgner, R.L. 1991. The life history of sockeye salmon (Oncorhynchus nerka). In C. Groot and L. Margolis (eds.), Life history of Pacific salmon, p. 3-117. Univ. B.C. Press, Vancouver, B.C.

Cykler-Ignac, K. 2001. Investigation of the effects of hydraulic variability on sockeye salmon in Lake Ozette, Washington. Natural Resource Management Program, Western Washington University. 8p.

Dalbey, S.R., T.E. McMahon and W. Fredenberg. 1996. Effect of electrofishing pulse shape and electrofishing-induced spinal injury to long-term growth and survival of wild rainbow trout. North American Journal of Fisheries Management 16:560-569.

Dlugokenski, C.E., W.H. Bradshaw, and S.R. Hager. 1981. An investigation of the limiting factors to Ozette Lake sockeye salmon production and a plan for their restoration. U.S. Fish and Wildlife Service, Fisheries Assistance Office, Olympia, WA. 52p.

Dwyer, W. P., and R. G. White,. 1997. Effect of Electroshock on Juveline Arctic Grayling And Yellowstone Cutthroat Trout Growth 100 Days after Treatment. North American Journal of Fisheries Management 17:174-177

Eiler, J. H., B. D. Nelson, R. F. Bradshaw, J. R. Greiner, and J. M. Lorenz. 1988. Distribution, stock composition, and location and habitat type of spawning areas used by sockeye salmon on the Taku River. NWAFC Processed Rep. 88-24, 44 p.

Foerster, R.E. 1968. The sockeye salmon - *Oncorhynchus nerka*. Bulletin 162. Fisheries Research Board of Canada. Ottawa. 422p.

Eiler, J. H., B. D. Nelson, and R. F. Bradshaw. 1992. Riverine spawning by sockeye salmon in the Taku River, Alaska and British Columbia. Trans. Am. Fish. Soc. 121(6):701-708.

Francis, R.C. and S.R. Hare. 1997. Regime scale climate forcing of salmon populations in the northeast Pacific - some new thoughts and findings, p. 113-128. *In* Emmett, R. L., and M.

H. Schiewe (eds.) Estuarine and ocean survival of northeastern Pacific salmon: Proceedings of the workshop. NOAA tech. memo. no. NMFS-NWFSC-29, NMFS NW Sci. Center, U.S. Dept. Commer. Nat. Marine Fish. Serv., Seattle, WA.

Fredenberg, W.A. 1992. Evaluation of electrofishing-induced spinal injuries resulting from field electrofishing surveys in Montana. Montana Department of Fish, Wildlife and Parks, Helena

Geiger, H.J. 1996. Recommendations to preserve and restore the Lake Ozette Sockeye Population: A Report following the May 8, 1996 review of population status at the Olympic National Park in Port Angeles, Washington, in *The sockeye salmon Oncorhynchus nerka population in lake Ozette, Washington, USA*, *Tech. Rep. NPS/CCSOSU/NRTR-96/04*, p. 111-121.

Gustafson, R.G., T.C. Wainwright, G.A. Winans, F.W. Waknitz, L.T. Parker, and R.S. Waples. 1997. Status review of sockeye salmon from Washington and Oregon. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-33, 282 p.

Halupka, K. C., J. K. Troyer, M. F. Wilson, M. B. Bryant, and F. H. Everest. 1993. Identification of unique and sensitive sockeye salmon stocks of Southeast Alaska (Draft Manuscript). For. Sc. Lab., Pac. N. W. Res. Stat., U.S. Dep. Agr., 235 p.

Hanamura, N. 1966. Salmon of the North Pacific Ocean -- Part III. A review of the life history of North Pacific salmon: Sockeye salmon in the far east. Int. North Pac. Fish. Comm. Bull. 18:1-27.

Hare, S.R., N. J. Mantua, and R. C. Francis. 1999. Inverse Production Regimes: Alaska and West Coast Pacific Salmon. Fisheries 24(1):6–14.

Heifitz, J., S. W. Johnson, K V. Koski, and M. L. Murphy. 1989. Migration timing, size, and salinity tolerance of sea-type sockeye salmon (Oncorhynchus nerka) in an Alaska estuary. Can. J. Fish. Aquat. Sci. 46:633-637.

Hollender, B.A. and R.F. Carline. 1994. Injury to wild brook trout by backpack electrofishing. North American Journal of Fisheries Management 14:643-649.

Jacobs, R., G. Larson, J. Meyer, N. Currence, J. Hinton, M. Adkison, R. Burgner, H. Geiger, and L. Lestelle. 1996. The sockeye salmon *Oncorhynchus nerka* population in Lake Ozette, Washington, USA. U.S. Dept. Interior, NPS Tech. Report NPS /CCSOSU /NRTR-96 /04.

Kemmerich, J. 1945. A review of the artificial propagation and transplantation of the sockeye salmon of the Puget Sound area in the state of Washington conducted by the federal government from 1896 to 1945. Unpubl. manusc., 76 p. plus tables. (Available from West Coast Sockeye Salmon Administrative Record, Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N. E. Oregon Street, Portland, OR 97232.)

Kramer, R. 1953. Completion report by stream clearing unit on Ozette and Big Rivers, 1953. Robert Kramer, supervisor, Stream Clearance Projects, Stream Improvement Division. Washington Department of Fisheries. 11p.

Lawson, P.W. 1993. Cycles in ocean productivity, trends in habitat quality, and the restoration of salmon runs in Oregon. Fisheries 18(8):6-10.

Lestelle, L. 1996. Recommendations for developing an approach for the restoration of Ozette sockeye salmon, in *The sockeye salmon Oncorhynchus nerka population in lake Ozette, Washington, USA, Tech. Rep. NPS/CCSOSU/NRTR-96/04*, p. 123-140.

Lorenz, J. M., and J. H. Eiler. 1989. Spawning habitat and redd characteristics of sockeye salmon in the glacial Taku River, British Columbia and Alaska. Trans. Am. Fish. Soc. 118:495-502.

Makah (Makah Indian Tribe). 1998. Comments on hatchery stock questions. Letter from Dave Sonnes, Makah Tribal council, to Robin Waples, Northwest Fisheries Science Center. October 30, 1998. Makah Indian Tribe. Neah Bay, WA. 5p.

Makah. 2000. Lake Ozette sockeye - hatchery and genetic management plan - Biological assessment, section 7 consultation. October 23, 2000. Prepared by Makah Fisheries Management for Bureau of Indian Affairs. Makah Indian Tribe. Neah Bay, WA. 219p.

Makah and NMFS MML (National Marine Fisheries Service - Marine Mammal Lab). 2000. Predation assessment, capture, tagging, and survey of adult Ozette Lake sockeye. Fisheries Management Department, Makah Indian Tribe. Neah Bay, WA.

MFM (Makah Fisheries Management). 2000. Lake Ozette sockeye HGMP: co-manager comments and Makah Fisheries Management responses. Makah Fisheries Management, Makah Indian Tribe. Neah Bay, WA. November 20, 2000. 42p.

MFMD (Makah Fisheries Management Department). No date. Ozette sockeye. (Prepared for 1992-93 Washington State Salmon and Steelhead Stock Inventory). 2 p. (Available from West Coast Sockeye Salmon Administrative Record, Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N. E. Oregon Street, Portland, OR 97232.)

McHenry, M.L., D.C. Morrill, and N. Currence. 1994. Spawning gravel quality, watershed characteristics and early life history survival of coho salmon and steelhead in five North Olympic Peninsula watersheds. Unpublished study funded by the Washington Department of Ecology, Centennial Clean Water Fund, and Section 205J Clean Water Act. Lower Elwha S'Klallam Tribe, Port Angeles, WA and Makah Tribe, Neah Bay, WA. 60p. plus Appendices.

McMichael, G.A. 1993. Examination of electrofishing injury and short-term mortality in hatchery rainbow trout. North American Journal of Fisheries Management 13:229-233

Montgomery, D.R., J. Buffington, N. Peterson, D. Schuett-Hames, and T. Quinn. 1996. Streambed scour, egg burial depths, and the influence of salmonid spawning on bed surface mobility and embryo survival. Can. J. Fish. Aquat. Sci. 53:1061-1070.

Murphy, M.L., K V. Koski, J. M. Lorenz, and J. F. Thedinga. 1988. Migrations of juvenile salmon in the Taku River, Southeast Alaska. NWAFC Processed Rep. 88-31, 39 p. Northwest and Alaska Fish. Cent., Natl. Mar. Fish. Serv., NOAA, 2725 Montlake Blvd. E., Seattle, WA 98112.

Murphy, M. L., J. Heifetz, J. F. Thedinga, S. W. Johnson, and K V. Koski. 1989. Habitat utilization by juvenile Pacific salmon (Oncorhynchus) in the glacial Taku River, Southeast Alaska. Can. J. Fish. Aquat. Sci. 46:1677-1685.

Murphy, M. L., J. M. Lorenz, and K V. Koski. 1991. Population estimates of juvenile salmon downstream migrants in the Taku River, Alaska. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-F/NWC 203, 27 p.

Mysak, L.A. 1986. El Nino, interannual variability and fisheries in the northeast Pacific Ocean. Can. J. Fish. Aquat. Sci. 43:464-497.

Natural Resources Consultants (NRC). 1995. Artificial propagation of anadromous Pacific salmonids: west coast sockeye salmon. Electronic database submitted to Coastal Zone and Estuarine Studies Division, Northwest Fisheries Science Center, Natl. Mar. Fish. Serv. Contract No. 50ABNF400128, 1.8 MB.

NMFS (National Marine Fisheries Service). 1997. Investigation of scientific information on the impacts of California sea lions and Pacific harbor seals on salmonids and on the coastal ecosystems of Washington, Oregon, and California. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-28. 172p.

NMFS. 1999a. Status Review of Coastal Cutthroat Trout from Washington, Idaho, Oregon, and California. NOAA Technical Memo.NMFS-NWFSC-37. 292 pp.

NMFS. 1999b. The Habitat Approach: Implementation of Section 7 of the Endangered Species Act for Actions Affecting the Habitat of Pacific Anadromous Salmonids. Prepared by The National Marine Fisheries Service, Northwest Region, Habitat Conservation and Protected resources Divisions, August 26, 1999.

NMFS. 2000a. White Paper: Salmon and steelhead hatcheries - the problems. NMFS, Sustainable Fisheries Division, Portland, Oregon. February 3, 2000.

NMFS. 2000b. Endangered Species Act - Reinitiated Section 7 Consultation - Effects of Pacific Coast Ocean and Puget Sound Salmon Fisheries During the 200-2001 Annual Regulatory Cycle. NMFS, Protected Resources Division. April 28, 2000. 96pp.

NMFS. 2000c. Guidelines for Electrofishing Waters Containing Salmonids Listed under the Endangered Species Act. Protected Resources Division, NMFS, Portland, Oregon. June 2000.

NMFS. 2000d. Guidelines for Electrofishing Waters Containing Salmonids Listed under the Endangered Species Act. Protected Resources Division, NMFS, Portland, Oregon. June 2000.

NMFS. 2002. Lake Ozette Sockeye Salmon Resource Management Plan-Hatchery and Genetic Management Plan Component Unpubl. manusc. NMFS Sustainable Fisheries Division.

Nehlsen, W., J. E. Williams, and J. A. Lichatowich. 1991. Pacific salmon at the crossroads: Stocks at risk from California, Oregon, Idaho, and Washington. Fisheries 16(2):4-21.

Pacific Fisheries Management Council. 2000. Review of 1999 Ocean Salmon Fisheries. February 2000.

Pacific Northwest Fish Health Protection Committee. 1989. Model comprehensive fish health protection program. 19p.

Peterson, N.P., A. Hendry, and T.P. Quinn. 1992. Assessment of cumulative effects on salmonid habitat: some suggested parameters and target conditions. Report prepared for the Department of Natural Resources and the Cooperative Monitoring, Evaluation and Research Committee of TFW. TFW-F3-92-001. University of Washington, Seattle, WA.

Quinn, T.P. 1985. Homing and evolution of sockeye salmon (Oncorhynchus nerka). In M. A. Rankin (editor), Migration: Mechanisms and adaptive significance. Contrib. Mar. Sci. (Suppl.) 27:353-366.

Quinn, T. P., C. C. Wood, L. Margolis, B. E. Riddell, and K. D. Hyatt. 1987. Homing in wild sockeye salmon (Oncorhynchus nerka) populations as inferred from differences in parasite prevalence and allozyme allele frequencies. Can. J. Fish. Aquat. Sci. 44:1963-1971.

Ricker, W. E. 1938. "Residual" and kokanee salmon in Cultus Lake. J. Fish. Res. Board Can. 4(3):192-218.

Rounsefell, G. A., and G. B. Kelez. 1938. The salmon and salmon fisheries of Swiftsure Bank, Puget Sound, and the Fraser River. U.S. Bur. Fish., Bull. 49:693-823.

Sharber, N.G. and S.W. Carothers. 1988. Influence of electrofishing pulse shape on spinal injuries in adult rainbow trout. North American Journal of Fisheries Management 8:117-122.

Sharber, N. G., S. W. Carothers, J.P. Sharber, J. D. deBos, Jr., and D. A. House. 1994. Reducing electrofishing-induced injury of rainbow trout. North American Journal of Fisheries Management 14:340-346.

Snyder, D. L. 1992 Impacts of Electrofishing on fish. Contribution number 50 of the Larval Fish Laboratory, Colorado State University, Fort Collins

Snyder, D.E. 1995. Impacts of electrofishing on fish. Fisheries 20(1):26-27.

Thompson, K.G., E.P. Bergersen, R.B. Nehring and D.C. Bowden. 1997. Long-term effects of electrofishing on growth and body condition of brown and rainbow trout. . North American Journal of Fisheries Management 17:154-159.

United States Fish and Wildlife Service. 1996. Policy regarding the recognition of distinct vertebrate population segments under the Endangered Species Act. Federal Register [7 February 1996] 61(26):4722-4725.

Waples 1991. NOAA Technical Memorandum entitled “Definition of ‘Species’ Under the Endangered Species Act: Application to Pacific Salmon.” March 19, 1998.

WDF (Washington Department of Fisheries). 1974. 1974 fisheries statistical report, p. 108-110. State Printing Plant, Olympia, WA.

WDF, Washington Department of Wildlife (WDW), and Western Washington Treaty Indian Tribes (WWTIT). 1993. 1992 Washington State salmon and steelhead stock inventory (SASSI). Wash. Dep. Fish Wildlife, Olympia, 212p. and 5 regional volumes. (Available from Washington Department of Fish and Wildlife, 600 Capitol Way N, Olympia, WA 98501-1091.)

WDFW (Washington Department of Wildlife), and Western Washington Treaty Indian Tribes (WWTIT). 1993. 1992 Washington State salmon and steelhead stock inventory (SASSI). Wash. Dep. Fish Wildlife, Olympia, 212p. and 5 regional volumes. (Available from Washington Department of Fish and Wildlife, 600 Capitol Way N, Olympia, WA 98501-1091.)

WDFW and the Point No Point Treaty (WDFW/PNPT). 2000. Summer Chum Salmon Conservation Initiative: An implementation plan to recovery summer chum in the Hood Canal and Strait of Juan de Fuca Region. Wash. Dept. Fish and Wild., Olympia, WA. 423 p. + appendix.

Wood, C. C. 1995. Life history variation and population structure in sockeye salmon. In J. L. Nielsen (editor), Evolution and the aquatic ecosystem: defining unique units in population conservation. Am. Fish. Soc. Symp. 17:195-216.

Wood, C. C., B. E. Riddell, and D. T. Rutherford. 1987. Alternative juvenile life histories of sockeye salmon (Oncorhynchus nerka) and their contribution to production in the Stikine River, northern British Columbia. Can. Spec. Publ. Fish. Aquat. Sci. 96:12-24.